Dubakella Plantations Insect & Disease Project

Fuels/Fire Report

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Introduction

The intent of this report is to evaluate the extent to which modification and reduction of fuels under the proposed action will meet the purpose and need for the project. This analysis will focus on all areas planned for silvicultural and fuel reduction treatments within the Dubakella watershed, which surrounds the community of Wildwood, in southeastern Trinity County, California. Plantation thinning prescriptions have been designed to develop and maintain vigorous, healthy plantations that will be more resilient to natural disturbances, including insects, disease, and wildfire. Increasing resiliency to insects and disease in overstocked stands will be accomplished through a combination of thinning treatments followed by fuels treatments. Thinning and fuels reduction treatments have been designed to decrease inter-tree competition and improve heterogeneity. Thinning prescriptions favor retention of tree species historically representative of the site and any inter-planting of openings will be done using a species mix representative of the surrounding natural stands. To further increase the stands' resiliency to insect and disease issues, while encouraging the development of late successional forest characteristics, fuels treatments have been developed to reduce the risk of crown fires by reducing fuel loading, raising canopy base height, and reducing canopy cover and bulk density. Prescribed burning is planned as a follow-up to plantation treatments and is also proposed for approximately 610 acres of natural stands that lie between plantations and control features (roads, ridges, streams, other plantations, etc.). This report will describe the effects of the proposed action in terms of potential future fire behavior.

Relevant Laws, Regulations, and Policy

Regulatory Framework

Land and Resource Management Plan

The Shasta-Trinity National Forest Land and Resource Management Plan (LRMP) (1995) provides the following standards and guidelines for fire and fuels management:

- Restore fire to its natural role in the ecosystem when establishing the Desired Future Condition of the landscape (Forest Plan, 4-4).
- Protect air quality while achieving land and resource management goals and objectives. Baseline levels will be established, and available technology will be used to predict and monitor changes. Activities such as burning, which are under the Forests' control, will be coordinated with affected landowners and control agencies (Forest Plan, 4-13).
- Activity fuels that remain after meeting wildlife, riparian, soil, and other environmental needs will be considered surplus and a potential fire hazard. The amount and method of disposal will be determined in the ecosystem analysis (Forest Plan, 4-17).
- Plan and implement fuel treatments emphasizing those treatments that will replicate fires natural role in the ecosystems (Forest Plan, 4-18).
- Natural fuels will be treated in the following order of priority: (1) public safety; (2) high investment situations (structural improvements, powerlines, plantations, etc.); (3) known high fire occurrence areas; and (4) coordinated resource benefits, i.e., ecosystem maintenance for natural fire regimes (Forest Plan, 4-18).
- Consider fuelbreak construction investments when they complement Forest health/biomass reduction needs, very high and extensive resource values are at risk and to protect Forest communities (Forest Plan, 4-18).

Desired Condition

Project-wide

Fire is a key ecosystem process that has largely been excluded from this landscape through more than 100 years of fire suppression. The desired stand conditions would allow for the reintroduction of fire and would be more resilient to wildfire and endemic levels of disease and insect activity.

The desired fuel profiles would limit fire behavior to surface fire and reduce the probability of crown fire initiation and propagation under the 90th percentile fuel moisture and weather conditions common in mid- to late-summer. The desired fuel profiles would have discontinuous surface fuel loading (to reduce potential flame length), disconnected ladder fuels (to limit the possibility of torching), increased canopy spacing (to limit crown fire spread), and retention of large trees of fire resilient species (to reduce post-fire mortality and restore historic stand structure) (Agee and Skinner 2005). The desired condition would also increase the likelihood that firefighters could safely and effectively engage a fire directly with hand tools, engines, dozers, and aircraft.

The manipulation of fuels and application of fire in this project is intended to restore and maintain resilient forest structure. Multiple introductions of fire may be necessary to achieve the desired condition, and periodic burning will be necessary to maintain the desired condition.

Unplanned wildfire within the proposed treatment area, before and/or following treatment, is a possibility that may not result in a changed condition. A burn severity pattern that resembles the historic pattern (primarily low severity effects with pockets of moderate and high severity effects), and/or achieves the desired condition that would result from planned activities, would be considered acceptable because it would move the project area toward a resilient forest structure.

In the natural stands, the following language from the Forest-wide Late Successional Reserve Assessment (1999) will guide the evaluation of unplanned wildfires:

> It is desirable to have low to moderate intensity fires burn in LSRs/MLSAs. Low intensity fires can reduce fine fuels and ladder fuels, create a seedbed for a diversity of herbaceous plants, and create a patchy understory open enough for spotted owl movements. Moderate intensity fires are desirable if they create small openings in the canopy of a less than one to five acres in size. This allows for ingrowth of tree seedlings and other early successional plants, and creates snag patches and concentrations of down woody debris which are important prey base habitats. Burn openings are most desirable if they occupy only a small percentage (5-10%) of the stands providing habitat….In addition, the introduction of a fire cycle more similar to that which occurred in pre-suppression times, will reduce the risk of catastrophic fires. Large stand replacing, high intensity fires are not desirable within LSRs/MLSAs. (Chapter 3, Desired Conditions, page 163).

Post-fire assessment of northern spotted owl habitat may involve the use of a burn severity assessment (such as the one described below) to determine whether suitable habitat functionality has been maintained.

In plantations, a post-fire assessment will determine the extent to which the unplanned wildfire moved the plantation(s) toward the desired condition. The appropriate activities described in the proposed action would be implemented to maintain the desired condition or continue to move the plantation(s) toward the desired condition.

Within northern spotted owl (NSO) habitat/natural stands

The goal of prescribed fire in NSO habitat is to maintain suitable habitat functionality by maintaining a sustainable late-successional forest structure and increasing resilience to future disturbance, such as stand-replacing wildfire. Both the Forest Wide Late Successional Reserve Assessment and the Revised Recovery Plan for the Northern Spotted Owl support this goal and advocate for monitoring the effects of restoration efforts. The intent of prescribed fire in NSO habitat is to utilize primarily low intensity fire (0-4' surface flame lengths), with pockets of moderate intensity fire (4-6' surface flame lengths), to create meaningful fire effects without removing habitat functionality.

Fire severity is defined as the effect of fire on an ecosystem or the degree of change to ecosystem components (Agee 1993; Sugihara el al 2006). A burn severity assessment will follow each prescribed fire to determine its ecological significance. One protocol for measuring burn severity is Composite Burn Index (CBI), which evaluates the degree of change for each of five strata, ranging from the forest floor to the upper canopy, and aggregates numerical scores into a final rating within a 30-meter plot (Key and Benson 2006). The CBI scale ranges from 0 (unburned) to 3 (highest burn effect). The ideal CBI burn severity rating for NSO habitat would likely average around 1.0 (low severity) and would, ideally, not exceed 1.5 (the low end of moderate severity). CBI is not the only way to measure burn severity, and monitoring of fire effects for this project should not be limited to a single protocol, as more effective means for measure change may become available. However, the CBI protocol is useful for determining the indicators and ideal ranges of fire effects within each stratum of the stand (Table 1).

Table 1. Burn Severity Assessment – Ideal Range for Each Severity Indicator, Comparison to CBI

Strata / Rating Factor	Ideal Burn Severity Indicator Range	CBI Score Range
Substrates		
Litter and light fuels (0-3") consumed	50 – 100% litter; 25 – 90% light fuels	1.0 – 2.5
Duff	Light char - 50% consumption, deep char	1.0 – 2.0
Medium fuel (3-8")	20 – 40% consumption	1.0 – 2.0
Heavy fuel (>8")	10 – 35% consumption, deep char	1.0 – 2.5
Total soil/rock cover	10 – 50 % soil cover change	1.0 – 2.5
Herbs, Low Shrubs, and Trees Less Than 3 Feet		
Percent foliage altered (black/brown)*	30 – 80%	1.0 – 2.0
Frequency percent living*	20 – 90%	1.0 – 2.5
Anticipated colonizer potential	Low - Moderate	1.0 – 2.0
Anticipated change in species composition/ relative abundance 2-3 years post-burn	Low - Moderate	1.0 – 2.0
Tall Shrubs and Trees 3 to 16 feet		
Percent foliage altered (black/brown)	10 – 50%	0.5 – 1.5
Frequency percent living	45 – 95%	0.5 – 1.5
Percent change in cover	5 – 55%	0.5 – 1.5
Anticipated change in species composition/ relative abundance 2-3 years post-burn	Low - Moderate	0.5 – 1.5
Intermediate Trees (Sub-canopy, Pole-sized Trees)		
Percent green (unaltered)	80 – 100%	0 – 1.0
Percent black (torched)	0 – 20%	0 – 1.0
Percent brown (scorched/girdled)	0 – 20%	0 – 1.0
Percent canopy mortality	0 – 15%	0 – 1.0
Char height	0 – 5 ft	0 – 1.0
Big Trees (Upper Canopy, Dominant and Codominant Trees)		
Percent green (unaltered)	90 – 100%	0 – 1.0
Percent black (torched)	0 – 10%	0 – 1.0
Percent brown (scorched/girdled)	0 – 10%	0 – 1.0
Percent canopy mortality	0 – 10%	0 – 1.0
Char height	0 – 6 ft	0 – 1.0

* Many fire-killed low shrubs and trees will still be standing and contain branches; they will continue to provide structure without live needles/leaves.

Burn severity will be determined as an average across the habitat within the area burned. Heterogeneous fire effects will be expected and encouraged, as they create the features that define habitat functionality. Burn severity will be determined by completing a series of plots according to a protocol such as CBI. Plot density will be sufficient to provide an adequate assessment of all the habitat burned as a part of this project (e.g. one plot per 25 acres of habitat). Plots will be completed as soon after completion of the burn as is feasible. However, it may be necessary to wait until enough acres are burned to get an adequate assessment of severity. In prescribed fire scenarios, it can be expected that the greatest degree of change will occur in the lower strata. Individual indicators (e.g. litter and light fuel consumed) or strata (e.g. substrates) may fall outside the ideal range while the entire plot rates as a desired severity. Individual plots may also reflect a severity outside the desired range, while the average of all plots reflects a burn severity within the desired ranges. Departures from the desired range, whether too hot or cool, will be treated as opportunities to study and refine the fire intensities, burn techniques, and/or prescription elements in order to create positive outcomes going forward.

Management Area, Allocations, Prescriptions, and Designations

The project area is within the Wildwood Management Area, and the proposed action will move the treated acres toward the desired future condition for the management area. Additionally, as it pertains to fuels management and the reintroduction of fire, the proposed action

- is consistent with the Roaded Recreation, Wildlife Habitat, and Commercial Wood Products prescriptions,
- is designed to work toward meeting the Aquatic Conservations Strategy objectives in the Riparian Reserves,
- is consistent with the desired condition outlined in the Forest Wide Late Successional Reserve Assessment, and
- is consistent with the objectives of the Hayfork Adaptive Management Area.

Approximately 1,832 acres (61%) of the project are within the Wildland Urban Interface, as designated by the Trinity County Community Wildfire Protection Plan and recognized in the Shasta-Trinity National Forest Fire Management Reference System.

All but the three acres of the project is in Fire Regime Group I (Safford and Van De Water 2014), which is characterized by frequent low and mixed severity fires (Sugihara et al 2006). The remaining 3 acres are areas of montane chaparral characterized as Group II because they tend to burn with same frequency as Group I, but with a higher severity. Over 99 percent of the burnable acres within the project are considered Condition Class 3, which indicates a high degree of departure from the historic fire return interval (Safford and Van De Water 2014). A small portion of the project is in Condition Class 2, which indicates a moderate level of departure. For more detail, see the Existing Condition.

Federal, State, and Local Law

Clean Air Act

This project complies with the Clean Air Act, and all prescribed burning will be regulated under Title 17 of the California Code of Regulations. All prescribed fire activities associated with this project will be conducted under a smoke management plan approved by the North Coast Unified Air Quality Management District, or any other required air quality district or entity. Prescribed burning will be conducted with the appropriate burn day authorization, and all required burn permits will be obtained.

Topics and Issues Addressed in This Analysis

Purpose and Need

This report will evaluate the extent to which the proposed action will meet the purpose and need as they relate to forest resilience to catastrophic wildfire.

Other Resource Concerns

This report also includes a qualitative discussion of how potential impacts to air quality will be mitigated and communicated.

Resource Indicators and Measures

Flame length and fire type are the two resource indicators used to measure the proposed action’s indirect effects on future wildfire.

Flame length, the average distance from the base of the flame to its highest point (which is different from vertical flame height) provides an illustration of fire intensity. Fire intensity can be an indicator for potential fire severity. Flame length can also illustrate potential suppression difficulty (See Methodology). Flame length will be classified into 6 bins based on feet. The measure will be the amount of the project area on which each class of flame length can be expected.

Fire type will be distinguished as surface fire, passive crown fire (torching), and active crown fire. Fire type illustrates potential fire effects, as crown fire in the forest types included in this project typically indicates a higher degree of burn severity than surface fire. Fire type can also illustrate potential suppression difficulty. The measure will be the amount of the project area on which each type of fire is predicted.

It is important to note that fire behavior predictions should not be interpreted as absolutes but, rather, as predictions of trends based on static 90th percentile conditions across the entire project area.

Table 2. Resource Indicators and Measures for Assessing Effects

Resource Element	Resource Indicator	Measure
Potential Fire Behavior	Flame Length (feet)	Acres / Percent of project area
Potential Fire Behavior	Fire Type	Acres / Percent of project area

Methodology

The analysis for this report relies on fire behavior prediction to quantify the effects of the proposed action. From a fire behavior perspective, live and dead vegetation can be described in terms of fuels. Surface fuels are comprised of grasses, forbs, shrubs, needle/leaf litter, shrubs and downed woody debris. The various combinations of surface fuels are described by fuel models that generalize surface fuels into functional categories for use in the fire behavior models. Forest canopy characteristics (canopy base height, canopy bulk density, canopy height, and canopy cover) are also used in fire behavior modeling to determine whether fire can spread vertically from the surface to the canopy (crown fire initiation/passive crown fire/torching), as well as whether it can spread horizontally through the canopy (active crown fire).

Fire behavior modeling was done within the Interagency Fuels Treatment Decision Support System (IFTDSS) web-based modeling environment (See Information Sources). IFTDSS was used to acquire baseline landscape data from the 2014 version of LANDFIRE (a database of 30-meter-resolution spatial landscape data generated through remote sensing and refined by field verification and professional judgement). Landscape characteristics from LANDFIRE (fuel model, canopy cover, canopy bulk density, canopy height, canopy base height, slope, elevation, and aspect) were validated by spot checks in the field. The baseline landscape was edited within IFTDSS to reflect the existing condition (i.e. landscape-scale changes that had occurred since the 2014 update of LANDFIRE, such as the 2015 wildfires that affected the project area). IFTDSS incorporates the Forest Vegetation Simulator and Fire & Fuels Extension (FVS/FFE) to model changes to fuel model and canopy characteristics that result from various levels of burn severity, as well as post-fire and post-treatment vegetation response and surface fuel accumulation (IFTDSS 2019). The 2015 fire footprints were modified using shapefiles for low, moderate, and high severity burned areas (based on Composite Burn Index (CBI) and obtained through the Rapid Assessment of Vegetation Condition after Wildfire (RAVG) dataset); then, 2 – 5 years of vegetation growth was added to the landscape. Further corrections to the fuel model data for the analysis area were based on experience and professional judgement. Within high-severity burned areas the sparse grass fuel model was converted to grass and shrub. The landscape was also updated to reflect the sparse fuels in serpentine areas; fuel model pixels that fell within the Serpentine Rattlesnake Terrane boundary were reduced to the lowest fire behavior producing model for the fuel type.

The landscape editing functionality of IFTDSS was also used to create the post-treatment landscape. Predictions of post-treatment fuel models and canopy characteristics were also based on a combination of professional judgement, experience with wildland fire in similar fuel types, and FVS outputs from previous plantation thinning projects. Edits were made to the existing condition landscape based on the proposed action and prescription for each unit. The following landscape edits were made:

Plantations identified primarily for thinning and follow-up fuels treatment:

- Where (Fuel Model is equal to 165) change (Fuel Model set to 186)
- Where (Fuel Model is greater than or equal to 142 AND Fuel Model is less than or equal to 149) change (Fuel Model set to 121)
- Where (Fuel Model is equal to 122) change (Fuel Model set to 121)
- Where (Fuel Model is equal to 184) change (Fuel Model set to 183)
- Where (Fuel Model is equal to 187) change (Fuel Model set to 183)
- Where (Canopy Bulk Density is greater than 0 kg/m^3) change (Canopy Bulk Density multiply by 0.55)
- Where (Canopy Cover is greater than 0 percent) change (Canopy Cover multiply by 0.67)
- Where (Canopy Base Height is less than 2 meters AND Canopy Base Height is greater than 0 meters) change (Canopy Base Height set to 2 meters)
- Where (Canopy Base Height is greater than 2 meters AND Canopy Base Height is less than or equal to 5 meters) change (Canopy Base Height multiply by 2)

Plantations identified primarily for fuels treatment:

- Where (Fuel Model is equal to 165) change (Fuel Model set to 186)
- Where (Fuel Model is greater than or equal to 142 AND Fuel Model is less than or equal to 149) change (Fuel Model set to 121)
- Where (Fuel Model is equal to 122) change (Fuel Model set to 121)
- Where (Fuel Model is equal to 184) change (Fuel Model set to 183)
- Where (Fuel Model is equal to 187) change (Fuel Model set to 183)
- Where (Canopy Base Height is greater than 0 meters AND Canopy Base Height is less than 2 meters) change (Canopy Base Height set to 2 meters)

The canopy adjustments above describe the anticipated changes to canopy characteristics that will result from thinning and pruning. The fuel model changes above reflect fuels treatments intended to reduce ladder fuels (small tree or brush understory), brush height and continuity, and surface fuel loading as a follow-up post-thinning, or as primary treatment before the application of broadcast prescribed fire. After the above edits were made, low severity fire was applied to these units to reflect broadcast prescribed burning, which is intended to further reduce surface loading (including litter and duff), increase canopy base height, and drive ecosystem functions like nutrient cycling. Post-burn vegetation response and surface fuel accumulation was modeled for 1, 2 – 5 (median of 4), and 6 - 10 (median of 8) years post-burn. The natural stand units outside of plantations received only the broadcast prescribed fire edits to the landscape. Table 3 describes the changes in fuel model used for fire behavior calculations for existing condition and 1 year, 2-5 years, and 6-10 years post-treatment scenarios. Post-treatment canopy characteristics (which are not represented here, but are in the project files) change more slowly and have less bearing on post-treatment fire behavior predictions. The first post-treatment increases in predicted fire behavior have more to do with fuel model changes that predict an increase in fire line intensity and flame length (See Direct and Indirect Effects).

Table 3. Anticipated Effects of Treatment to Fuel Model

	Existing Condition		**1 year post-treatment**		**2 - 5 years post-treatment**		**6 - 10 years post-treatment**	
Fuel Model	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
91 - non-burnable	58	2	58	2	58	2	58	2
101 - primary carrier of fire is sparse grass	60	2	65	2	144	5	65	2
102 - primary carrier of fire is grass	307	10	307	10	683	23	684	23
121 - grass (low load) and shrubs (1' high) combined	145	5	760	26	234	8	369	12
122 - grass (moderate load) and shrubs (1'-3' high) combined	483	16	5	0	5	0	20	1
142 - woody shrubs (moderate load; 1' high) and shrub litter	1	0	0	0	72	2	0	0
147 - woody shrubs (very high load; 4'-6' high) and shrub litter	149	5	0	0	0	0	0	0
165 - heavy forest litter with shrub or small tree understory	844	28	0	0	0	0	287	10
183 - moderate load of conifer litter; light load coarse fuels	59	2	189	6	189	6	189	6
184 - moderate load of fine litter and coarse fuels (small downed logs)	11	0	15	1	15	1	0	0
186 - moderate load of broadleaf litter	36	1	1,279	43	1,275	43	431	15
187 - heavy load forest litter (large downed logs)	138	5	0	0	0	0	15	1
188 - moderate load of long-needle pine litter	673	23	282	10	287	10	484	16
189 - very high load broadleaf litter / needle-drape in brush understory	0	0	0	0	0	0	363	12

Historic fuel moisture and weather conditions were used to model future conditions. 90th percentile fuel moisture conditions were used to predict fire behavior for each 30-meter pixel in the project area. Fuel moistures were obtained from the Percentile Weather function of the Fire Family Plus (Bradshaw and McCormick 2000) program using data collected by the Yolla Bolla Remote Automated Weather Station (RAWS) during the period of May 1 to October 31 from 2008 to 2017. The values represent the actual combination of fuel moistures that have resulted in an Energy Release Component (an index within the National Fire Danger Rating System used to measure seasonal-scale trends in fire danger) in the 90th percentile. In other words, the values used have occurred on only 10 percent of the fire-season days between 2008 and 2017. The intent is to capture the peak fire season conditions that would test the efficacy of the proposed action in meeting the purpose and need. Fire Family Plus was also used to analyze historic wind patterns based on hourly observations from 1200 to 1900, between May 1 and October 31, 2008 to 2017, at the Yolla Bolla RAWS. The 90th percentile wind speed (converted from 10-minute average to 1 minute average) is 8 miles per hour (Crosby and Chandler 1966). A wind rose analysis demonstrated that strong winds typically occur out of the south/southeast. Table 4 displays the values used for analysis.

Table 4. 90th Percentile Fuel Moisture and Wind Parameters

Parameter	Value
1-hour fuel moisture (0 to 0.25 inch diameter)	3%
10-hour fuel moisture (0.25 to 1 inch diameter)	4%
100-hour fuel moisture (1 to 3 inch diameter)	6%
Herbaceous fuel moisture	30%
Woody fuel moisture	70%
Foliar Moisture	100%
20-foot wind speed, direction	8 miles per hour, 160 degrees

Potential fire behavior under the 90th percentile conditions for the existing condition and post-treatment landscapes was determined with the Landscape Fire Behavior tool within IFTDSS. Landscape Fire Behavior incorporates elements of FlamMap (Finney 2006), a fire behavior analysis and mapping program that predicts a variety of fire behavior characteristics for individual pixels across a digitized landscape. Fire behavior in this analysis is described in terms of flame length and fire type (surface, passive crown (torching), active crown) for each 30-meter pixel in the landscape under 90th percentile conditions. An actual wildfire would burn under a range of conditions and potentially over a number of days, but this method is an opportunity to evaluate the entire landscape on the same terms in order to illuminate trends.

Flame length and fire type can be indicators of potential suppression difficulty and fire effects on ecosystem components. In forest ecosystems, high-intensity fire behavior can be an indicator of potential high-severity fire effects like vegetation mortality resulting from canopy consumption or heat-related tissue damage. High-severity effects can also result from long-duration low-intensity burning, such as in areas of heavy fuel loading. Fireline intensity is the rate of energy release per unit length of flaming front, and flame length is the measurement related to fireline intensity that can be easily visualized or measured in the field (Sugihara et al., 2006). Increased flame lengths can increase the likelihood of torching and active crown fire. Flame length is influenced by fuel type, fuel loading, fuel arrangement, fuel moisture, and weather conditions. Flame length and fireline intensity influence production rates, or how fast firelines can be constructed by different suppression resources, including hand crews and mechanical equipment. Flame lengths over 4 feet, or fireline intensities over 100 BTU per foot per second, may present serious control problems. These conditions are too dangerous to be directly contained by hand crews (Schlobohm and Brian 2002; Andrews and Rothermel 1982). Flame lengths over 8 feet, or fireline intensities over 500 BTU per foot per second, are generally not controllable by ground-based equipment or aerial retardant, and present serious control problems including torching, crowning, and spotting. Flame length and fireline intensity directly affect suppression tactics. Table 5 outlines how flame lengths and fireline intensities influence fire suppression actions (Andrews et al. 2011).

Table 5. Relationship Between Flame Length, Fireline Intensity, and Suppression Actions

Flame length		Fireline intensity		Suppression Actions
Feet	Meters	Btu/ft/s	kJ/m/s	
< 4	< 1.2	< 100	<350	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4 – 8	1.2 – 2.4	100 – 500	350 – 1700	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, engines, and retardant aircraft can be effective.
8 – 11	2.4 – 3.4	500 – 1000	1700 – 3500	Fires may present serious control problems—torching, crowning, and spotting. Control efforts at the fire head will probably be ineffective
> 11	> 3.4	> 1000	> 3500	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Whether a crown fire initiates depends on surface fireline intensity, canopy base height, and foliar moisture content (the live fuel moisture in the needles/leaves of canopy tree species). The combination of high flame length, branches close to the forest floor, and sufficiently low canopy moisture conditions (the foliar moisture content for this analysis was set to 100 percent, which is typical for peak fire season conditions) can facilitate fire spread into the canopy. Passive crown fire describes single trees or groups of trees torching. Active crown fire, or fire continuing to propagate through the canopy, requires a sufficient sustained surface fireline intensity, canopy bulk density, and wind speed.

Information Sources

- The Interagency Fuel Treatment Decision Support System (IFTDSS) is a web-based fuel treatment evaluation environment (Drury et al 2015). It pulls landscape data from LANDFIRE and allows the user to edit the data to reflect landscape changes due to wildfires and vegetation/fuels treatments. It also allows the user to run basic fire behavior scenarios on the edited landscape because FlamMap is incorporated into the IFTDSS environment. IFTDSS also incorporates elements of the Forest Vegetation Simulator (FVS) in order to model vegetation growth and fuel accumulation post-treatment.
- The LANDFIRE Data Access Tool (2014) was used to obtain LANDFIRE Data Products used in GIS analysis (e.g., vegetation, fuel models, fuel characteristics classification system data, canopy characteristics, and topography).
- Shasta-Trinity National Forest GIS shapefiles were used to analyze information regarding roads, plantations, riparian reserves, wildlife habitat, fire history, fire origins, and wildland urban interface.
- USFS Pacific Southwest Regional GIS shapefiles were used to identify fire regime groups, fire return interval departure, and condition class (Safford and Van de Water 2014).
- Weather data was obtained from the Weather Information Management System, Western Region Climate Center, Kansas City Fire Access Software, and the National Fire and Aviation Management Web Applications (FAMWEB).

Incomplete and Unavailable Information

The Jones fire (1959) does not currently exist in forest-level or regional GIS data. Leslie Warta, NEPA Planner for the South Fork Management Unit, digitized the estimated fire perimeter based on aerial photographs from before and after the fire, as well as first-hand accounts from a former USFS employee who observed the fire.

Fire occurrence data from 1982 to 2012 was utilized to describe the Existing Condition because it was the longest duration recent data set available within the forest-level GIS library. Although more recent years are not included, professional judgement indicates that this data set accurately depicts trends in fire occurrence for the area.

Minor discrepancies between total project acreage and total acreage in Tables 3 and 6 are due to the fact that rasterized landscape data exists in 30-meter-resolution square pixels that don’t entirely match the edges of project GIS polygons.

Spatial and Temporal Context for Effects Analysis

The spatial extent of the effects analysis is the proposed treatment area. Landscape fire behavior predictions for area outside the proposed treatments, but within watershed, are in the IFTDSS project files. The temporal extent of effect analysis is ten years following the establishment of the desired condition. However, the proposed action includes maintenance of the desired condition through the use of fuels treatments. These maintenance treatments will extend the treatment effects until conditions are significantly changed by some other mechanism.

Affected Environment

Existing Condition

Prior to the mid-twentieth century, when fire suppression became effective in the area, the project vicinity experienced frequent low-severity and mixed-severity fires (Fire Regime Group I). The average fire return interval throughout the area ranged from 11 to 29 years. Based on fire history studies conducted just west of Hayfork, some locations may have experienced only two to five years between fires (Taylor and Skinner 2003). Nearly all of the project acres (99.5%) are now considered highly departed (Condition Class 3) from their historic fire return interval, and approximately 17 acres (0.5%) are moderately departed (Condition Class 2). Fire occurrence data indicates that the Dubakella watershed experienced 75 wildfire ignitions between 1982 and 2012, and the majority of those ignitions (57%) were the result of lightning. Although the average is 2.4 fires per year, lightning ignitions tend to occur within lightning events that could result in more than the average number of fires in any given year. There were several years between 1982 and 2012 when 4 to 6 lightning fires were detected. Lightning fires in the project vicinity have tended to cluster in the area between South Dubakella Mountain and the 30 road, around McFarland Ridge, near Brushy Mountain, and in the area of the Chanchelulla Wilderness. Human-caused fires have clustered around the higher-traffic roads and in the vicinity of Wildwood.

Although several large wildfires have occurred in the watershed in the last century, only approximately 817 acres (27%) of the proposed treatment area has burned. The 610 acres of natural stands identified for treatment in this project have no recorded fire history. The century of fire exclusion has put these stands at risk for forest health issues and the effects of high-severity wildfires. Several large fires have affected the plantations identified for treatment. An estimated 639 acres proposed for treatment in this project burned in the Jones (1959) fire. Many of these acres were established as plantations following the fire and have since become overstocked, prone to forest health issues, and at-risk for high-severity fire effects. More recently, the Telephone (2008) and Shiell (2015) fires burned 85 and 93 proposed plantation treatment acres, respectively. Although some proposed treatment areas have been affected by past fires, they are still moderately to highly departed from the historic fire return interval. These plantations still have surface fuel loading or canopy characteristics that could lead to high-severity fire effects in future wildfires. Forest health issues related to insects and disease are currently visible in many plantations proposed for treatment. Those plantations that are not currently exhibiting evidence of insect or disease issues have been identified as at risk for future forest health issues.

Environmental Consequences

Direct and Indirect Effects

The direct effects of the proposed action are changes to the surface and canopy fuels. As noted in the Methodology section, plantation units with a silvicultural prescription would undergo more extensive changes to canopy cover and canopy bulk density. However, all plantations would have the canopy base height raised to a minimum of approximately 6.5 feet. Follow-up prescribed fire in plantations and burning in natural stands will also raise canopy base height. The proposed action will thin the shrubs and small trees from the timber understory, particularly where they create a ladder into canopy fuels. There will also be reduced shrub loading in non-timbered areas and a general reduction in surface fuel loading.

Indirect effects of the proposed action include reductions in potential fire behavior. Table 6 contains 90th percentile fire behavior predictions for the existing condition and post-treatment scenarios at 1 year, 2-5 years, and 6-10 years. As noted above, fire predictions are not absolute and are intended to elucidate trends inherent in the project area when each 30-meter pixel of the landscape burns under the same 90th percentile conditions.

Existing landscape conditions could result in flame lengths in excess of 11 feet over 33 percent of the project area, with torching occurring on 46 percent of the project area. The amount of predicted active crown fire is relatively low, which is likely due to the relatively low wind speed used for calculations (which is derived from the historically low wind speeds recorded at the nearby RAWS). Wind conditions closer to the 97th or 100th percentiles could potentially lead to more active crown fire. Regardless, the predicted flame lengths and torching fire behavior would lead to high severity fire effects on a significant portion of the project area. A fire under the existing condition would exhibit a high degree of resistance to control, as firefighters with hand tools would be effective on only 41 percent of the project area, and engines, dozers, and/or aircraft would be needed on roughly 22 percent of the project area. Direct control efforts would be largely ineffective on 37 percent of the project area.

The proposed action is expected to limit fire behavior to surface fire spread on all burnable acres of the project area 1 year after treatment. This reduction in crown fire activity is due to the reduced flame lengths and the higher canopy base height that will result from the proposed action. A year after treatment, firefighters with hand tools would be effective on 93 percent of the project area; engines, dozers, or aircraft would only be needed on 7 percent of the acreage, and flame lengths are not expected to exceed 8 feet within a year of treatment. Those acres with flame lengths exceeding 4 feet are likely a grass fuel model, within openings within the forest that are likely to remain as grass regardless of silvicultural or prescribed fire treatments.

As the treatments in the proposed action age, surface fuels will accumulate and vegetation (particularly brush and small trees) will re-sprout or grow from seed. The proposed treatments remain effective, for the most part, out to 10 years. However, it’s around 10 years that fire behavior trends begin to register the initial pulse toward an increase beyond desired thresholds. Therefore, maintenance of the initial treatments, primarily with prescribed fire, is recommended within 10 years, which is consistent with the historic, pre-fire-suppression fire regime.

Table 6. Potential 90th Percentile Fire Behavior (Flame Length & Fire Type)

	Existing Condition		**1 year post-treatment**		**2 - 5 years post-treatment**		**6 - 10 years post-treatment**	
Flame Length (feet)	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
No Fire	58	2	58	2	58	2	58	2
0 - 1	75	3	195	7	207	7	187	6
1 - 4	1,077	36	2,493	84	2,268	76	2,008	68
4 - 8	643	22	223	7	436	15	693	23
8 - 11	143	5	0	0	0	0	5	0
11 +	972	32	0	0	0	0	18	1
Fire Type	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**	**Acres**	**Percent**
No Fire	58	2	58	2	58	2	58	2
Surface Fire	1548	52	2908	98	2908	98	2882	97
Passive Crown Fire (Torching)	1362	46	3	0	3	0	29	1
Active Crown Fire	1	0	0	0	0	0	0	0

The prescribed burning elements of the proposed action are expected to have both direct and indirect effects to air quality in the form of smoke. Ambient Air Quality Standards (AAQS) for criteria pollutants were considered for each county that could potentially be affected by this project. All treatment units are located in Trinity County, which is identified as attainment or unclassified for ozone, carbon monoxide, sulfur oxides, lead, respirable particulate matter (PM10), and fine particulate matter (PM2.5) for federal standards. Neighboring Shasta and Tehama counties are also in attainment or unclassified for national AAQS. Therefore, the project complies with the General Conformity Rule.

The southernmost edge of the project is approximately 6 miles from the nearest Class I airshed (Yolla Bolly Middle Eel Wilderness). Smoke Management Plans associated with this project may be required to identify this Class I airshed as a sensitive receptor. Prescribed fire activities will be coordinated and approved by the local air district(s) so that burning is unlikely to impede the progress of the California Regional Haze Plan.

Prescribed burning in California is regulated under Title 17 of the California Code of Regulations. All prescribed fire activities associated with this project will be conducted under a smoke management plan approved by the North Coast Unified Air Quality Management District, or any other required air quality district or entity. Smoke management plans and/or prescribed fire plans associated with this project may describe possible smoke mitigation measures, particularly as they relate to mitigating impacts to the Yolla Bolly Wilderness, Highway 36, Wildwood, the St Xenia's Skete Monastery, and any additional sensitive receptors. Possible smoke mitigation measures may include, but are not limited to, burning when atmospheric conditions are ideal for dispersion, reducing the acreage burned when conditions are less than ideal, timing prescribed fire ahead of precipitation events to reduce the duration of burning, or curtailing ignitions early enough in the day to reduce the amount of smoke that can settle under nighttime temperature inversions. Smoke management plans may also disclose expected emissions values for some or all of the criteria pollutants. Smoke management plans and/or prescribed fire burn plans associated with this project may identify the methods and schedule for communicating with the public about the potential smoke impacts from prescribed fires. Prescribed burning will be conducted with the appropriate burn day authorization, and all required burn permits will be obtained.

Cumulative Effects

All past actions that could have cumulative effects, when combined with the proposed action, have been incorporated into the baseline landscape data. The potential cumulative effect of smoke from other sources outside of this project footprint will be managed through the coordination with the relevant air quality management districts mentioned above.

Summary

The proposed action is expected to meet the desired condition by disrupting the current horizontal and vertical continuity of fuels and reducing the potential fire behavior under 90th percentile conditions to primarily low-intensity surface fire. The initial treatments and maintenance activities, particularly the reintroduction of fire as a landscape process, are expected to result in resilient forest structure and composition.

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